Surveys for the Green and Golden Bell Frog *Litoria aurea* by the State Forests of New South Wales

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ABSTRACT

Since 1992 State Forests of New South Wales have conducted 16 surveys which have included the Green and Golden Bell Frog *Litoria aurea* as a target species. The majority of these surveys have been concentrated in northeastern New South Wales, an area from which there are few records. Despite the widespread coverage provided by the surveys, this species was not recorded. The indications are that the species is rare in the forest environments which were the main target of the surveys. The survey results also suggest that *L. aurea* remains rare in other habitats within northern New South Wales. Future surveys for this species need to be directed more towards non-forest areas, particularly on the coast, and there is a requirement for further survey work in southeastern New South Wales.

INTRODUCTION

The Green and Golden Bell Frog *Litoria aurea* is a large, semi-aquatic frog noted to be associated with permanent and semi-permanent water bodies (e.g., swamps, dams and streams) through an apparently wide range of environments (Courtice and Grigg 1975; Barker and Grigg 1977; Cogger 1992). Its historical range covers the coast and adjacent ranges of southeastern Australia (Cogger 1992). In New South Wales, *L. aurea* has been recorded from Ocean Shores, near Brunswick Heads, to the Victorian border, but with relatively few records from north of Sydney, particularly above 100 m (see White and Pyke 1996).

The majority of the Green and Golden Bell Frog's range in New South Wales is also concurrent within timber production management areas (MAs) of the State Forests of New South Wales (SFNSW). Since 1992, there has been a requirement under the *National Parks and Wildlife Act* 1974, for the SFNSW to undertake a programme of Fauna Impact Statements (FISs) to assess the impacts of forestry operations on any species of endangered fauna found within areas to be significantly affected by forestry activities (MAs). The green and golden bell frog is listed as endangered on the Revised (Interim) Schedule 12 of the *National Parks and Wildlife Act* 1974, and so has been required to be addressed in FISs performed within its known range. As part of the FIS process, SFNSW has undertaken a series of surveys targeting this (as well as other) species to provide information on their distribution, abundance and habitat preferences within each of the areas subject to an FIS.

This paper reports on the surveys performed for Green and Golden Bell Frogs by SFNSW. It also discusses the future directions SFNSW should consider in surveying for this species.

STUDY AREAS

SFNSW has performed 16 surveys covering lands within the known New South Wales range of the Green and Golden Bell Frog (Fig. 1). These surveys have included two inland and one coastal area of southern New South Wales, but have been mainly concentrated in northern New South Wales (seven upland and six coastal). The areas surveyed have encompassed a wide altitudinal range and a variety of habitat types including rainforest, wet and dry sclerophyll forests, open woodlands, swamplands and lands cleared for agriculture (Table 1).

SURVEY METHODS

The surveys were performed by environmental consultants contracted by the SFNSW (see Table 1). The methods employed were those described in York *et al.* (1992) and NPWS/SFNSW (1994). The surveys used two main approaches which specifically sampled frogs. These are summarized below:

1. Road transects — roads in the study area were traversed at night in order to locate frogs crossing the road. Usually these transects were performed in a car (although some foot searches were carried out) and preferentially they were undertaken after periods of rainfall. Road surveys were also used to locate water bodies surveyed as in 2 below;
2. Riparian searches — water bodies were surveyed for frogs by firstly listening for the calls of male frogs (on average for five minutes) followed by a foot inspection of the site using a light. The riparian searches

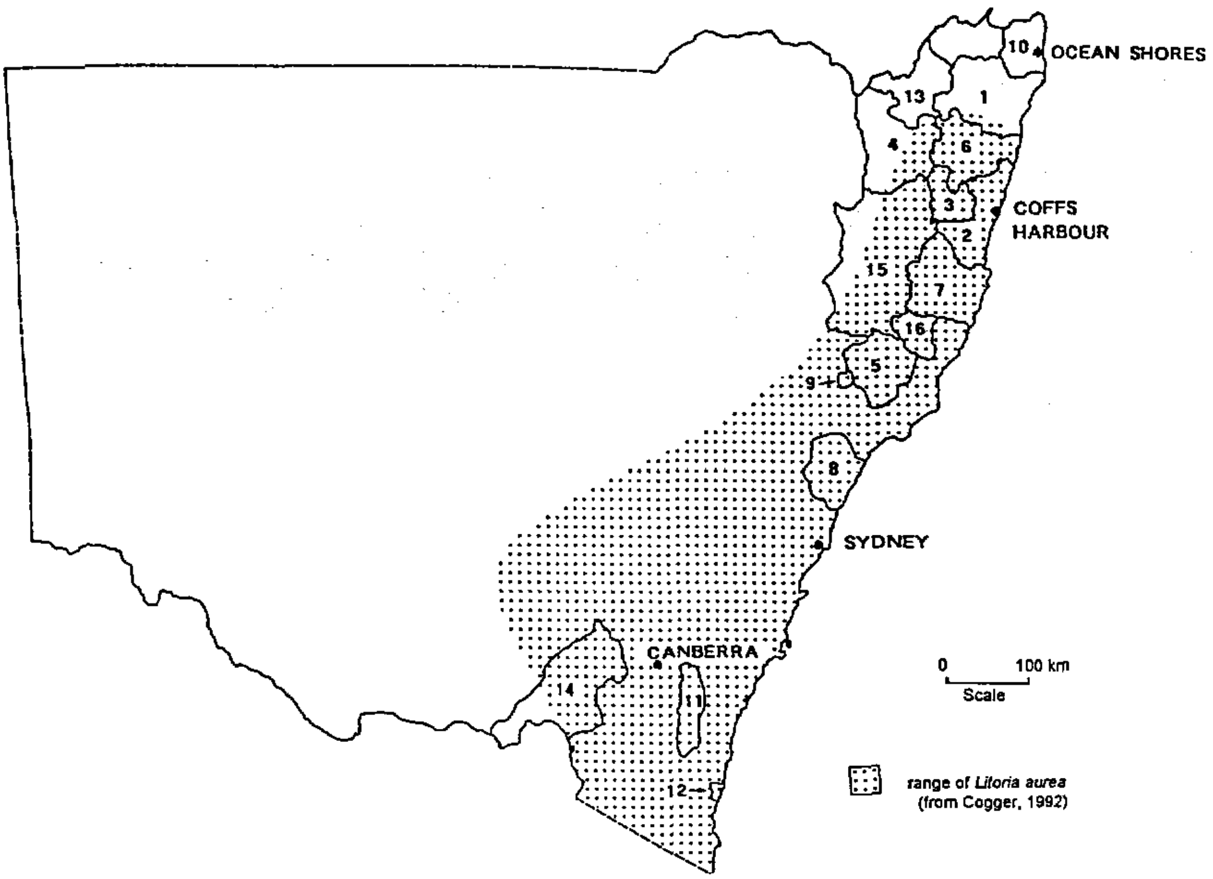

Fig. 1. Distribution of the FIS Survey Areas through New South Wales.

Table 1. Summary of the areas surveyed by the State Forests of New South Wales since 1992.

Survey Area	Surveyors	Survey Year/s	Survey Months	Altitude (metres)	Habitats Surveyed[1]	Pre-survey Records[2]	Reference/s
1. Casino	C. Barker	1991/92	Dec., May	150–800	RF, DS, WS	1	Smith *et al.* 1994
2. Coffs/Urunga	C. Barker	1993/94	Feb.–Mar.	0–1 000	RF, WS, DS, HL	4	Austeco 1993, 1994
3. Dorrigo	F. Lemckert	1993/94	Sept.–Feb.	740–1 100	DS, WS, RF, CL	0	Lemckert 1995a
4. Glen Innes	G. Clancy and P. Webber	1991	Sept.–Nov.	900–1 200	RF, WS, DS	0	Smith *et al.* 1992
5. Gloucester	A. White	1994	Oct.–Dec.	200–1 500	RF, WS, DS, RP	0	White 1994
6. Grafton	C. Barker	1991/92	Dec.–May	150–1 100	RF, WS, DS	2	Smith *et al.* 1994
7. Kempsey	M. Denny and D. Read	1992	Jan.–Apr.	10–1 200	RF, WS, DS, HL, CL	1	Denny 1993
8. Morisset	R. Wells and R. Wellington	1993	Jan.–Mar.	100–900	WS, DS, OW, CL	20	Wellington and Wells 1995
9. Mt. Royal	G. Clancy	1991	Jan.–Mar.	300–1 300	WS, RF	0	Shields *et al.* 1992
10. Murwillumbah	A. Manning	1992	Apr.–May	0–1 100	RF, WS, DS, CL	1	A. Manning, unpubl. data
11. Queanbeyan	R. Goldingay and G. Daly	1993, 1995	Oct.–Nov., Jan.	300–1 470	OW, WS, DS, CL	0[3]	QEM 1994; Goldingay *et al.* 1995
12. Tathra	F. Lemckert	1993	Apr.	0–100	DS, HL, CL	2	Lemckert *et al.* 1993
13. Tenterfield	G. Daly and F. Lemckert	1992	Feb.	600–1 200	RF, WS, DS, CL	1	Fanning 1994
14. Tumut	F. Lemckert	1994/95	Nov., Feb., Mar.	200–1 000	DS, OW, CL	1[3]	Lemckert 1995b
15. Walcha	P. Webber	1995	Jan.–Feb.	0–1 400	RF, WS, DS, CL	0	Webber *et al.* 1995
16. Wingham	G. Clancy	1991	Nov.	130–1 200	RF, DS, WS, CL	0	Clancy 1992

[1] RF = Rainforest, WS = Wet Sclerophyll, DS = Dry Sclerophyll, OW = Open Woodland, HL = Heathland, CL = Cleared Lands

[2] Number of records of the Green and Golden Bell Frog known from the survey areas prior to the survey (information obtained from the identified reports, Courtice and Grigg 1975, and A. White, pers. comm.).

[3] The identity of the species in the southern highland areas remains uncertain (S. Thomson, pers. comm.).

Table 2. Summary of Survey Effort for each FIS[1].

Survey Area	No. survey nights	Breeding sites surveyed	No. suitable breeding sites[2]	Suitable sites in suitable habitat[3]	No. pitfall trap days	No. species recorded
1. Casino	5	10–15	?	?	1 120	20
2. Coffs/Urunga	28	35	16	5	1 680	15
3. Dorrigo	22	212	118	37	0	29
4. Glen Innes	8	15–20	?	?	1 624	24
5. Gloucester	15	116	36	5	3 640	22
6. Grafton	5	10–15	?	?	1 036	20
7. Kempsey	5	27	15	?	4 480	16
8. Morisset	5	25	22	21	1 320	17
9. Mt. Royal	4	10–20	?	?	152	2
10. Murwillumbah	15	13	10	0	448	13
11. Queanbeyan	19	49	49	19	100	15
12. Tathra	3	18	10	10	0	7
13. Tenterfield	18	47	31	19	5 040	17
14. Tumut	13	173	117	117	0	11
15. Walcha	6	24	17	10	3 780	13
16. Wingham	18	6	6	6	3 150	11

[1] The actual number of nights of survey and sites surveyed were not always accurately recorded and the figures listed represent only the minimum effort (and could have been much greater).

[2] "Suitable" sites were permanent or near-permanent *still or slow moving* water bodies.

[3] Represented by "suitable" sites within clearings or on cleared lands, or any large swamp.

varied in time, depending on the size and shape of the water body, and could be as short as five minutes or could take more than an hour. Where possible, inspections of the area were carried out prior to the night search to locate habitat particularly suitable for the species being targeted during the survey. These sites were noted for aural and visual survey to maximize the opportunity to locate species of particular interest.

The timing and extent of the survey for each species were determined by the consultant contracted to undertake the survey. In general, surveys were concentrated in the spring and summer months, but some surveys were necessarily undertaken during other periods of the year (Table 1). The location, date and time of survey were always recorded for each riparian site and each road record, but the other information noted depended on the surveyor involved.

In addition, 13 of these surveys also used pitfall traps to sample fauna. The traps were 10 or 20 litre plastic buckets (usually the latter) buried with their top flush with the ground and generally sheltered with a bitumen-coated aluminium sheet (York *et al.* 1991). In all except the Queanbeyan surveys, the bottom of these traps were filled with formalin to kill and preserve the trapped animals. These traps were placed along transects in forest types of specific interest (see York *et al.* 1991 for more details) and left open for at least 14 days. These traps were not used in combination with drift fences (except at Queanbeyan; see QEM, 1994) and were not expected to catch large numbers of animals. They were however, open for a large number of trap nights (see Table 2) and so were expected to (and did) catch some frogs, including species not collected by other methods.

RESULTS

No direct observations were made of Green and Golden Bell Frogs during these surveys which was disappointing given the degree of effort that was placed into surveys for this and other amphibian species (see Table 2). Not all riparian sites surveyed would have been appropriate for Green and Golden Bell Frogs, but at least 431 were considered to represent suitable habitat for this species in being permanent or near permanent water bodies that this species is supposedly associated with. Additionally, the road surveys traversed a minimum of 5 000 km of roads which covered a broad diversity of habitats and conditions.

The only information pertaining to green and golden bell frogs obtained through this time were two "old" observations provided by forestry workers. Dewi Wright (pers. comm.) from the Queanbeyan District indicated that during the mid 1970s a large (8–10 cm) greenish frog was common in the reeds present in streams leading into Lake Jindabyne and in the water courses around Bombala. This description almost certainly refers to a species of Golden Bell Frog which was common in the area at that time, but which apparently disappeared in the late 1970s (A. White, pers. comm.). It should be noted that the identity of the species from this area is uncertain and it may have been *Litoria aurea, Litoria raniformis* or an undescribed species (S. Thomson, pers. comm.).

Secondly, incidental talks with Allan Douch (pers. comm.) from the Narooma District indicated that a land holder on a property adjacent to Wallaga Lake (25 km south of Narooma) had reported regularly hearing and seeing this species on his property during the early 1980s. The land holder, who had been very familiar with these frogs, was quite certain they were green and golden bell frogs and had been very disappointed when the species had disappeared. A survey of the site by Narooma District Staff in January 1994 failed to find any indications of the species at the site.

DISCUSSION

That no direct records of Green and Golden Bell Frogs were obtained during these surveys was something of a surprise. Pre-survey records were available for nine of the MAs in which surveys were held (Table 1), including very recent records (post 1990) for the Morisset, Grafton, Murwillumbah, Coffs Harbour and Tathra areas (White and Pyke 1996). Therefore, some populations were expected to be located. The obvious question then is why were Green and Golden Bell Frogs not recorded? Was this frog truly absent from the survey areas, or was it a case of the surveys failing to locate the species? Answering this question has important implications as if the former is the case, then it confirms the apparent decline or loss of the Golden Bell Frog through part of its range; if it was the latter, then significant populations may have gone undetected, and so left unprotected.

If the surveys failed to locate this species, even though it was present, there are two obvious explanations as to why this may have occurred. Firstly, the surveys could have been poorly timed (performed in the wrong season or in inappropriate conditions) resulting in the frogs being very difficult to locate. Secondly, the survey methods or personnel used could have been inappropriate, resulting in the frog being overlooked when it was actually present.

Both of the above cases appear unlikely to provide more than a partial explanation. Only three surveys were performed outside of the preferred calling season of August to January (Robinson 1993). Furthermore, both Robinson (1993) and A. White (pers. comm.) indicate that adults can be located at other times and, in particular, juveniles can be detected around water bodies during cooler months (Fletcher 1889; F. Lemckert, pers. obs.). This suggests that the failure to locate Green and Golden Bell Frogs can not really be attributed to surveys being performed in inappropriate seasons.

A factor more likely to be of importance in terms of timing was that seven of the surveys were undertaken during the drought conditions prevailing in 1992 and 1993. Frogs generally require rainfall to stimulate reproduction (Salthe and Mecham 1974; Humphries 1979) and the drought may have suppressed breeding activity making the detection of frogs considerably more difficult. However, the surveys generally detected a large number of species (see Table 2) and if drought was significantly reducing frog activity the numbers of species recorded should have been low. Additionally, the Green and Golden Bell Frog is noted as a year-round resident of areas of permanent water (Dankers 1977; Humphries 1979). Even if breeding was curtailed, individual frogs should have been actively foraging and still relatively easy to locate around water bodies (F. Lemckert, pers. obs.).

In regards to possible problems with personnel and techniques, both York *et al.* 1992, and NPWS/SFNSW, 1994, rely on the surveyor to locate suitable habitat for the surveys and to be able to personally recognize the target animal. If people inexperienced with Golden Bell Frogs had performed the surveys it could have resulted in a poor selection of riparian survey sites and even a failure to recognize a frog when seen or heard. However, herpetologists known to be experienced with this species were employed in 12 of the 16 studies (Table 1) and, in the other four surveys, the people were at least experienced fauna surveyors. In all cases it appears reasonable to assume that the surveyors should have recognized or been able to identify any individuals of this species encountered, and should have known how to locate this species and the appropriate habitat to target. Certainly, these workers managed to locate large numbers of species (Table 2) including other rarely recorded species such as the Green-thighed Frog *Litoria brevipalmata* and Fleay's Barred Frog *Mixophyes fleayi.*

Rather, the survey results support the recent work of Pyke and White (1996) which indicates that the Green and Golden Bell Frog is a species rarely found within forested lands. The majority of these surveys were constrained by time and funding and so there was a greater concentration of survey effort into areas of forest (areas to be impacted) rather than into other habitats such as heath and cleared lands (which remain unaffected; see Table 2). The resultant lack of success suggests that at least forests may not be the preferred habitat of this species. This fact has not been recorded in profiles of the species by previous workers (e.g., Moore 1961; Courtice and Grigg 1975; Cogger 1992), but the review of the known records by Pyke and White (1996) shows few records to have come from within forests.

However, the complete absence of records still remains as something of a surprise as the road surveys covered large areas of cleared land when travelling to areas of forest (Green and Golden Bell Frogs are relatively conspicuous when crossing roads; F. Lemckert, pers. obs.) and some apparently appropriate sites on cleared lands were targeted in the majority of surveys (Table 2). Even if only three nights were spent on surveys, information from both Caughley and Gall (1985) and Lemckert (1995a) indicates that 75% of the species present and active at the time of the survey will be located, and this may be irrespective of the degree of rainfall (Lemckert 1995a). All of the surveys covered three or more nights (and often many more) which a least suggests that Green and Golden Bell Frogs were absent not just from the areas of forest, but from all habitats.

It is recognized that the results presented here pertain mainly to the situation in northern New South Wales and provide relatively little information on the status of the Green and Golden Bell Frog in the southern part of its range (where few surveys have been conducted). Historically, this species is far less common on the north coast than it is on the south coast (White and Pyke 1996) or in coastal areas of Gippsland, Victoria (Gillespie 1996). If the Green and Golden Bell Frog remains common anywhere in New South Wales it is likely to be on the south coast, particularly in the large coastal swamps which historically have supported large populations (A. White, *pers. comm.*). Of the three surveys to the south of Sydney, only at Tathra was coastal habitat surveyed and the timing of the surveys, and the prevailing weather conditions, were not appropriate for a confident survey (Lemckert *et al.* 1993). Clearly the south coast needs to be the subject of more extensive surveys. It is likely that records of the species would be obtained from within areas of state forest as, unlike in northern New South Wales, state forests occur right to the coastline near Jervis Bay, Batemans Bay, Narooma and Eden (at Kioloa Green and Golden Bell Frogs are known to occur in a swamp within forested land; F. Lemckert, *pers. obs.*) and appear to include large coastal swamps. However, to maximize survey results, future surveys need to focus on non-forest areas as well as forested areas to demonstrate more conclusively that this species is not present within a survey area.

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